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(54) **METHOD AND APPARATUS FOR FORMING CUTS IN CATHETERS, GUIDEWIRES AND THE LIKE**

VERFAHREN SOWIE VORRICHTUNG ZUM SCHNEIDEN VON KATHETERN, FÜRUNGSDRÄHTEN, ODER DERGLEICHEN

PROCEDE ET APPAREIL DE FORMATION D'ENTAILLES DANS DES CATHETERS, DES FILS DE GUIDAGE ET ANALOGUE

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- **PATENT ABSTRACTS OF JAPAN vol. 1995, no. 02, 31 March 1995 (1995-03-31) & JP 06 312313 A (AMADA CO LTD), 8 November 1994 (1994-11-08)**

EP 0 934 141 B1

Description

BACKGROUND

1. Field of the Invention

[0001] The present invention pertains to making precision cuts in catheters and guidewires. Specifically, a device for holding, advancing, rotating and then cutting a catheter or guidewire is provided which is able to manipulate the catheter or guidewire in two degrees of freedom to enable precision control of the location of the cuts. Various clamping mechanisms are provided for manipulating the catheter or guidewire, as well as mechanisms for wear detection of saw blades used to make the cuts resulting in controlled variation in mechanical properties.

2. State of the Art

[0002] Making cuts in catheters and guidewires requires precision in order to ensure reliability because of the medical applications in which they are used. However, it is also important to control costs of production so that costs to the health care industry can be minimized.

[0003] The state of the art is typified by such devices as grinding wires, wound coils, and lasers for making the cuts. But these devices often suffer from high cost or imprecise or difficult control mechanisms for properly positioning both the device to make the cut and the cylindrical object to be cut.

[0004] The document US-A-4,574,670 provides the most relevant prior art.

[0005] What is needed is a method and apparatus for making cuts in catheters and guidewires which allows precise control of characteristics of the cuts. This entails precision holding, advancement and rotation of the generally cylindrical object while at least one saw blade is itself advanced to make the cut and retracted afterward.

OBJECTS AND SUMMARY OF THE INVENTION

[0006] It is an object of the present invention to provide a method and apparatus for forming precision cuts in catheters and guidewires.

[0007] It is another object to provide a method and apparatus for forming precision cuts in cylindrical objects.

[0008] It is yet another object to provide a method and apparatus for forming precision cuts by manipulating a cylindrical object in two degrees of freedom to control the parameters of the cuts.

[0009] It is still another object to provide a method and apparatus for holding, advancing and rotating a cylindrical object to be cut.

[0010] Still yet another object of the invention is to provide a method and apparatus for increasing throughput of a device which forms cuts in cylindrical objects by providing multiple saw blades on a single cutting tool.

[0011] It is another object to provide a method and apparatus for detecting the extent of wear of a saw blade in order to more precisely control the position of the saw blade.

[0012] According to the present invention there is provided a system for forming at least one precision cut in an elongate object as claimed in claim 1. Further according to the present invention there is provided a method of forming at least one precision cut in an elongate object such as a catheter or a guidewire as claimed in claim 28.

[0013] In a preferred embodiment the device includes a base which has at least one circular saw blade mounted on a spindle member, and a clamp for manipulating and positioning the object to be cut. The circular saw blade is rotatably mounted on the spindle member. The spindle member is free to move vertically and horizontally with respect to the base to thereby control the location, length, depth and angle of the cuts in a cylindrical object disposed adjacent thereto. The clamp is able to hold the object to be cut, as well as position it by, for example, rotation to thereby expose the entire circumference of the cylindrical object to the saw blade. By releasing the clamp, a pinch roller advances the cylindrical object before the clamp is re-engaged to securely hold the cylindrical object for cutting.

[0014] Another aspect of the embodiment is the ability to make precision cuts by providing means for controlling the rotation and advancement of the object to be cut and movement of the saw blade spindle member. Sensors are also provided to enable detection of wear on the saw blade so as to signal needed replacement or adjustment of the location of the saw blade spindle member to compensate.

[0015] Another aspect is the ability to simultaneously make a plurality of cuts in the object. This is accomplished with a saw blade having a plurality of blades in parallel. Even more cuts can be made by providing more than one saw blade spindle member, where each is independently movable in two degrees of freedom.

[0016] Another aspect of the embodiment is to provide more than one spindle member so that blades can simultaneously make precision cuts at different locations along the length of the cylindrical object.

[0017] These and other objects, features, advantages and alternative embodiments of the present invention will become apparent to those skilled in the art from a consideration of the following detailed description taken in combination with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

Figure 1A is a front elevational view of a preferred embodiment made in accordance with the princi-

ples of the present invention.

Figure 1B is a side elevational view of the invention shown in Figure 1A.

Figure 2 is an alternative embodiment of a vertically moving member shown reversed in orientation with respect to FIGS 1A and 1B.

Figure 3 is an alternative embodiment of a horizontally moving member shown reversed in orientation with respect to FIGS 1A and 1B.

Figure 4 is a block diagram of the preferred embodiment which shows a control means and sensor means for controlling position determination and movement of components.

Figure 5 is a block diagram showing signals which pass between components when using an electrical conduction sensor.

Figure 6 is a block diagram showing signals which pass between components when using a mechanical drag detection sensor.

Figure 7 is a block diagram showing signals which pass between components when using a rotation detector sensor.

Figure 8 is a block diagram showing signals which pass between components when using an optical detection sensor.

Figure 9 is an alternative saw blade assembly which can be used in all embodiments of the present invention.

Figure 10A is a top elevational view of an alternative clamping device.

Figure 10B is a side elevational view of the alternative clamping device of FIG. 11B.

Figure 11 is an alternative embodiment which uses two saw blade assemblies to simultaneously make incisions in the catheter.

DETAILED DESCRIPTION OF THE INVENTION

[0019] Reference will now be made to the drawings in which the various elements of the present invention will be given numerical designations and in which the invention will be discussed so as to enable one skilled in the art to make and use the invention.

[0020] The present invention is illustrated in FIGS. 1A and 1B. FIG. 1A is a front view of the preferred embodiment of the invention, and shows the system for forming precision cuts in a catheter, a guidewire, or other cylindrical objects. For purposes of keeping in mind the intended use of the present invention, a catheter will be referred to as the object being cut, although any cylindrical object can be substituted for the catheter. However, reference to the catheter is only for the convenience of writing in terms of a specific cylindrical object, and should not be considered a material limitation of the invention. However, referring to a catheter keeps present in mind the objective of having a very precise cutting device, where precision is paramount in most medical applications. Furthermore, a catheter is only one embodiment of a medical application, but which easily represents the need for precision.

[0021] The system 6 shown in FIGS. 1A and 1B is comprised of several elements including a base member 10 for supporting the structure. Coupled in sliding engagement with a vertical base member 12 is a vertically movable member 14 which has a first vertical coupling face 16 and a first horizontal coupling face 18. The vertical coupling face 16 is smilingly engaged with a base member vertical coupling face 20.

[0022] The mechanism 22 for enabling the sliding engagement between the vertical coupling face 16 and the base member vertical coupling face 20 can be any appropriate apparatus. The important consideration is that the vertically movable member 14 not be permitted to move horizontally, or the precision of the system will be compromised. Therefore, the tolerances of the mechanism 22 must necessarily be small. A good example of an appropriate mechanism 22 is well known to those skilled in the art as a crossed roller bearing slide.

[0023] The shape of the vertically movable member 14 is shown here as a small backwards "L". An alternative shape for the vertically movable member 14 is shown in FIG. 2. The member 14 is flipped over as compared to the embodiment of FIG. 1A. The important feature of the member 14 is that it provide two faces 16, 18 which can be slidably engaged to move vertically and provide a second face on which another member can slidably engage to move horizontally.

[0024] The system in FIGS. 1A and 1B is also comprised of a horizontally movable member 24 which has a spindle end 26 and a second horizontal coupling face 28. This horizontally movable member 24 is slidably engaged at its second horizontal coupling face 28 to the vertically movable member 14 at its first horizontal coupling face 18. It should be observed that the vertically movable member 14 and the horizontally movable member 24 are capable of moving independently of each other. In this way, the system achieves two independent degrees of freedom of movement.

[0025] The spindle end 26 of the horizontally movable member 24 provides a horizontal slot 30 in which a spindle 32 is disposed. The slot 30 is generally circular to serve as a receptor for the round shaft 34 of the spindle 32. The spindle shaft 34 has disposed on a working end 36 thereof at least one circular saw blade 38. The circular saw blade 38 is disposed vertically on the spindle shaft 34, but may also be angled in other embodiments.

[0026] The spindle shaft 34 is coupled to a drive motor by gears, belts, direct drive, or any other appropriate means (not shown) which will cause the spindle shaft 34 to rapidly rotate. The drive motor (not shown) can be disposed in any appropriate location relative to the spindle shaft. In a preferred embodiment, the spindle shaft 34 is driven by a brushless DC motor through a toothed timing belt.

[0027] The circular saw blade 38 is typical of those found in the art. In a preferred embodiment, the cutting

edge 40 of the saw blade 38 is coated with industrial diamonds.

[0028] The means for holding and otherwise manipulating a catheter 8 to be cut is the clamping member 50. The clamping member 50 is comprised of two major assemblies: the clamp 52 and the clamp feeding (supplying) means 54, or the device which feeds the catheter 8 to and then through the clamp 52. The clamping member 50 is also coupled to the base member 10 and disposed to hold the clamp 52 in a position for easy feeding of the catheter 8 to the circular saw blade 38.

[0029] In the preferred embodiment, the clamp 52 is of the type known to those skilled in the art as a collet clamp. A collet clamp is a slotted cylindrical clamp inserted tightly into the tapered interior of a sleeve or chuck on a lathe to hold a cylindrical piece of work. In FIG. 1A, the cylindrical shape of the clamp 52 is visible. It is slotted in that the clamping arms 58 are separate from each other so that they can pull away from the catheter 8 when disengaging, and then securely come together around the catheter 8 when engaging.

[0030] In a preferred embodiment, a desirable feature of the clamp 52 is that it is rotatably mounted within the clamping member 50. The collet clamp 52 can then rotate so as to dispose a different portion of the surface of the catheter 8 to the saw blades 38. The mechanism for rotating the clamp 52 is shown generally at 56, and is comprised of the clamp 52 which is held in a frame which can rotate with respect to the saw blade 38.

[0031] The clamp feeding (supplying) means 54 seen in FIG. 1B is shown in this preferred embodiment to be comprised of a pinch roller assembly 60, 62 working in conjunction with a feed roller 66. As FIG. 1B should make clear, the pinch roller assembly 60, 62 feeds the catheter 8 to the clamp 52 by using friction created between two opposing members 60, 66. The upper member is the pinch roller 60. The lower member is the feed roller 66. The feed roller 66 has an axle 68 mounted in the clamp feeding means 54 so that the feed roller 66 can roll. The pinch roller 60 is disposed at the end of a lever arm 62 which pivots at a pivoting end 76. Located distally from the pinch roller assembly along the length of the lever arm is a hole 72. One end of a spring 64 is inserted therethrough, and the other end of the spring 64 is coupled at another hole 74 to the clamp feeding means 54. The spring 64 provides the tension necessary for the feed roller 64 to push the catheter 8 to the clamp 52.

[0032] Having described most of the components in a preferred embodiment of the catheter cutting assembly 6, the operation of the assembly 6 is as follows. First, the uncut catheter 8 is placed between the pinch roller 60 and the feed roller 66. This can be done by raising the lever arm 62 by stretching the spring 64. Releasing the lever arm 62 causes the pinch roller 60 to push down against the feed roller 66, with the catheter 8 disposed therebetween. A drive mechanism (not shown) is coupled to the feed roller 66 to cause it to roll and thereby push the catheter 8 toward the clamp 52. The clamp 52 should be in a disengaged position (hole through clamp is larger than diameter of the catheter 8) so that the catheter 8 can be fed easily therethrough. After passing through the clamp 52, the catheter 8 is fed sufficiently far past the circular saw blade 38 so that it is in a proper position to have an incision made in or through its surface.

[0033] When the catheter 8 is positioned correctly, the clamp 52 is engaged and the saw blade 38 is advanced to make cutting contact. Before cutting, the saw blade 38 will always be positioned in a retracted position. The retracted position is both vertically below and horizontally pulled away from the catheter 8. The first movement of the saw blade 38 is 1) horizontal advancement toward the catheter 8. This is accomplished by moving the horizontally movable member 24 relative to the vertically movable member 14 to which it is attached. The horizontally movable member 24 is moved until it has reach the depth of the incision to be made in the catheter 8. The next step 2) comprises the vertically movable member 14 moving upwards relative to the base 10 to which is coupled to thereby make the cut. The saw blade 38 is then immediately retracted by moving the vertically movable member 14 away from the catheter 8. The horizontal member is moved only when the next cut is at a different depth or when all cutting is complete.

[0034] If another cut is to be made, the collet clamp 52 is released as step 4). The catheter 8 is then fed through the clamp 52 by the feed roller 66 as step 5). The collet clamp 52 is then re-engaged in step 6) and, if necessary, the collet clamp 52 is rotated to expose a different position of the catheter 8 to the saw blade 38. The saw blade 38 is then moved horizontally if the depth of cut is to change, and then vertically to make the cut and steps 1) through 7) repeat as often as necessary until all the incisions have been made or the catheter 8 is no longer capable of being grasped by the feed roller 66 and opposing pinch roller 60.

[0035] The above description of the operation of the catheter cutting system 6 describes the different roles served by the clamp 52. When the circular saw blade 38 is making a cut in the catheter 8, the clamp 52 holds the catheter 8 steady. When the cut has been made in the catheter 8, the catheter 8 is fed through the clamp 52 by causing the clamp to disengage from around the catheter 8. After being disengaged, the catheter 8 is fed through the clamp 52 until the next incision point on the catheter 8 is in position relative to the saw blade 38. The clamp 52 re-engages so as to be disposed snugly around the catheter 8 to again prevent movement of the catheter 8 during cutting.

[0036] It should be recognized from the description above that the width of a cut into the catheter 8 is limited to the width of the circular saw blade 38. A wider cut therefore requires that the catheter 8 be advanced slightly past the saw blade 38. However, advancement does not take place while making a cut. The saw blade

38 must be withdrawn so that the clamp 52 can disengage from around the catheter 8 while it is advanced. This is necessary because allowing cutting of the catheter 8 when the clamp is disengaged would create a useless if not imprecise cut..

[0037] Another vital component of the assembly 6 is a position sensing means. While it is now understood how the catheter 8 is cut, it is not been explained how the feed roller 66 knows when to stop feeding the catheter 8 through the clamp 52, or how far the clamp 52 needs to rotate before cutting commences. In other words, precision cutting also requires precision positioning of the catheter. Precise positioning requires sensors which can detect where the catheter 8 is in relation to the saw blade 38 and the clamp and then provide this information to some control device which coordinates movement of all components by sending the necessary signals to correctly position all of the system 6 components.

[0038] This concept is shown generally in the block diagram of FIG. 4. The catheter cutting system 6 is shown as having inputs from a control means 80 for positioning the vertically movable member 14 and shown as arrow 82, the input shown as arrow 84 for positioning the horizontally movable means 24, the arrow 86 which designates an input for controlling rotation of the clamp 52, and an arrow 88 which designates an input for controlling the feed roller 66. Two control inputs for the clamp and the spindle motor are also shown as arrows 87 and 89, respectively. The block diagram in FIG. 4 also shows a sensor means 90 for receiving position information from the system 6 as indicated by arrow 92. This information is transmitted to the control means 80 as indicated by arrow 94 so that it can be processed and the correct control signals 82, 84, 86, and 88 can be transmitted to the system 6.

[0039] There are several alternative methods for determining the position of the catheter 8 relative to the saw blade 38. These devices can all be substituted as the sensor means 90 of FIG. 4. The first device is an electrical conduction sensing circuit 100 shown in block diagram form as FIG. 5. It is sometimes the case that the materials used in catheters. 8 are electrically conductive. Furthermore, the saw blade 38 can also be electrically conductive. Consequently, bringing the saw blade 38 into contact with the conductive catheter 8 can result in the completion of an electrical circuit. By moving the saw blade 38 sufficiently slowly so as not to abruptly make contact with the catheter 8, the moment of contact can be used as a reference point so that the saw blade 38 can be moved the proper horizontal distance to make the desired cut.

[0040] FIG. 6 shows an alternative method of position sensing. In this embodiment, mechanical drag detection means is coupled to the saw blade 38. The drag detection means 102 can be coupled to either the driving means 104 of the saw blade 38, or the spindle 32 of the saw blade 38. In other words, the drag detection means 102 is any suitable device for detecting when a dragging force is encountered by the saw blade 38. For example, one device for this purpose is a torque transducer which measures the torque loading of the shaft which turns the blade 38.

[0041] FIG. 7 shows a related method of position sensing is to use a rotation detector means 106 which detects even slight partial revolutions of the saw blade 38 as the spindle is oscillated vertically and slowly advanced horizontally. With the blade 38 not spinning, rotation of the blade 38 will occur when slight contact is made between the blade with the catheter.

[0042] A final embodiment for detecting the position of the saw blade 38 relative to the catheter 8 is to use an optical detector 108, as shown in block diagram form in FIG. 8. The optical detector means 108 is disposed such that it can detect contact between the saw blade 38 and the catheter 8. There are various optical devices which can be used to implement this detector 108.

[0043] One aspect of the invention which is related to the various sensing means 90 described above is that not only is it important to know the position of the blade, but it is also important to know the degree of wear of the blade. All of the sensor embodiments above are inherently able to compensate for the wear which the blade 38 will experience. In other words, none of the methods for determining the exact position of the blade 38 rely on an assumption that the size of the blade 38 is constant. All of the sensor embodiments 90 account for saw blade 38 wear by dynamic determination of position which is not based on a predefined size of the saw blade 38. Instead, the sensors 90 determine when contact is being made, and adjust the position of the blade 38 or the catheter 8 accordingly.

[0044] FIG. 9 illustrates a modification to the spindle 32 and saw blade 38 arrangement shown in FIGS. 1A and 1B. Specifically, a plurality of saw blades 38 are shown as being mounted in parallel on the same spindle 32. This also means that the saw blades 38 are necessarily coaxial. It is also preferred that the saw blades 38 have the same diameter so that no individual saw blade 38 makes a deeper incision in the catheter 8 than any of the others. However, it should be apparent that if the spindle 32 or the saw blades 38 are easily detachable from the system 6, then saw blades of varying diameters might be mounted on the same spindle 32 to achieve a consistent pattern of cuts having different depths.

[0045] FIG. 10A, which is included for information purposes only, shows a clamp mechanism 120 which should be used in conjunction with the multiple saw blade 38 assembly of FIG. 10. The clamp mechanism 120 is capable of holding a catheter 8 in place while the catheter 8 is cut by the plurality of saw blades 38. This is accomplished by providing a clamping surface 122 having a depression or slot 124 for receiving the catheter 8. Coupled to the clamping surface is a leaf spring 126. The leaf spring 126 is comprised of several fingers 128 which force the catheter 8 to remain in the slot 124

while it is cut. Disposed perpendicular to the slot 124 and extending from the clamping surface 122 completely through the clamping mechanism 120 to a back side 136 are a plurality of slots 130 (which make clamp fingers 132) through which the saw blades 38 are extended to thereby cut the catheter 8. The fingers 128 of the leaf spring 126 are typically spaced apart a distance which is equal to the spacing between the plurality of slots 130. This ensures that the saw blades 38 do not inadvertently make contact with the leaf spring fingers 128 while cutting the catheter 8.

[0046] To allow the catheter 8 to be fed through the slot 124 in the clamping surface 122, there must be a mechanism for raising the fingers 128 of the leaf spring 126 from off the clamping surface 122. FIG. 11A shows a plurality of holes 134 through the clamping mechanism 120, one hole 134 per clamp finger 132. FIG. 10B, which is included for information purposes only, shows these holes 134, and more importantly, the plurality of push rods 136 which extend through the holes 134 from the back side 136 of the clamp mechanism 120 to the clamping surface 122. What is not shown is a lever arm or other mechanism which simultaneously pushes the plurality of push rods 136 when the clap mechanism 120 is instructed to disengage the clamp and move the catheter 8.

[0047] FIG. 12 is an illustration of another alternative embodiment of the present invention. The vertically movable member 14 is shown having another shape which enables it to have disposed thereon two horizontally movable members 24, each having its own associated saw blade or blades 38. This embodiment enables the catheter 8 to be simultaneously cut at different circumferentially defined points on the catheter surface. This is especially useful in making cuts in catheters which having multiple incisions, for example, on diametrically opposed positions on the catheter 8.

[0048] It should be noted that while the preferred embodiment has been defined as having a horizontally movable member with the spindle for the saw blade coupled thereto, the placement of the vertically and horizontally movable members can be switched. In this arrangement, the horizontally movable member is coupled to the base member and the vertically movable member, and the vertically movable member has a spindle rotatably coupled thereto.

[0049] An alternative embodiment of the present invention uses a lever arm which is capable of movement in at least two degrees of freedom so that it can move vertically and horizontally to position a spindle end.

[0050] Another aspect of the invention which should be clarified is that rotating the catheter is not limited to using a rotatable clamping mechanism. For example, the clamp can be non-rotatable and disengaged to enable the catheter feeding mechanism to rotate the catheter, and then reengage the clamp to make additional incisions. Furthermore, the clamp and the catheter feeding mechanism can be rotated together before additional incisions are made.

[0051] Alternative aspects of the invention include the substitution of a non-mechanical cutting instrument for the rotating blade of the presently preferred embodiment. For example, a laser can be provided for cutting through materials which are mounted on the system.

[0052] It should also be realized that rotating blades are not the only type of mechanical blade which can be utilized. Conventioned "sawing" blades can also be provided.

[0053] It is to be understood that the above-described embodiments are only illustrative of the application of the present invention. Numerous modifications and alternative arrangements may be devised by those skilled in the art without departing from the scope of the present invention. The appended claims are intended to cover such modifications and arrangements.

Claims

1. A system (6) for forming at least one precision cut in an elongate object (8) such as a catheter or a guidewire, wherein the precision cut is generally at an angle or transverse relative to a lengthwise axis of the elongate object, said system comprising:

   a securing device (50) comprising a collet clamp (52), configured to repeatedly release and then hold the elongate object in a position suitable for cutting the elongate object at an angle or transversely relative to the lengthwise axis;
   a manipulating device (54), including a feeding device, configured to move the elongate object so that it can be disposed in the position suitable for cutting when it is released by the securing device; and
   a cutting device (38) configured to form the at least one precision cut in the elongate object to any desired depth; and

   characterized in that the feeding device comprises a pinch roller assembly (60)

2. The cutting system as defined in claim 1, wherein the cutting device is further **characterized by**:

   a base member (10);
   a vertically movable member (14) slidably coupled to the base member;
   a horizontally movable member (24) having a spindle end (26) and being slidably coupled to the vertically movable member;
   at least one rotatable spindle (32) disposed through the spindle end;
   at least one circular saw blade (38) disposed coaxially on the spindle;

a drive device coupled to the at least one spindle for rotating the at least one circular saw blade; and

wherein the securing device (50) is coupled to the base member (10) and disposed to engage the elongate object while the at least one circular saw blade (38) makes an incision therethrough.

3. The cutting system as defined in claim 1, wherein the cutting device is further **characterized by**:

a base member (10);
a horizontally movable member (24) slidably coupled to the base member;
a vertically movable member (14) having a spindle end (26) and being slidably coupled to the horizontally movable member;
at least one rotatable spindle (32) disposed through the spindle end;
at least one circular saw blade (38) disposed coaxially on the spindle;
a drive device coupled to the at least one spindle for rotating the at least one circular saw blade; and

wherein the securing device (50) is coupled to the base member (10) and disposed to engage the elongate object while the at least one circular saw blade (38) makes an incision therethrough.

4. The cutting system as claimed in any of claims 1 to 3, wherein the cutting device (38) is further **characterized by** a means for moving the cutting device relative to the elongate object being held by the securing device (50) such that the precision cut can be made at an angle or transversely relative to the lengthwise axis of the elongate object.

5. The cutting system of any of the preceding claims, wherein the manipulation device (54) is adapted to permit the pushing, pulling and turning of the elongate object with respect to the cutting device (38) and the securing device (50).

6. The cutting system of any of the preceding claims, wherein the securing device (50) is further **characterized by** a device for rotating the collet clamp (52) while the clamp is holding the elongate object immobile, and while the cutting device (38) is cutting the elongate object.

7. The cutting system of any of the preceding claims, wherein the securing device (50), the manipulating device(54), and the cutting device (38) are movable and securable in a position with respect to each other, such that the elongate object can be positioned for cutting at a desired angle by the securing device and the manipulating device with respect to the cutting device.

8. The cutting system of any of the preceding claims, wherein the pinch roller assembly is further **characterized by**:

a first wheel (66) for supporting and forcing the elongate object to move to the securing device (50) when the securing device is disengaged;
a second wheel (60) for applying a force to the elongate object to thereby hold it against the first wheel, thereby providing friction to push the elongate object to the securing device (50); and
a lever arm (62) coupled to the base at pivoting end, and coupled to the second wheel (60) at a movable end, wherein a spring device (64) coupled between the lever arm and the base member (10) provides the force of the second wheel.

9. The cutting system of any of claims 2 to 8, wherein the vertically movable member (14) has a first vertical coupling face and a first horizontal coupling face, and is slidably coupled to the base member at the first vertical face.

10. The cutting system of claim 9, wherein the horizontally movable member (24) has a second horizontal coupling face, the horizontally movable member being slidably coupled at the second horizontal coupling face to the vertically movable member at the first horizontal coupling face.

11. The cutting system of any of the preceding claims, wherein the collet clamp (52) comprises a clamping hole, which the feeding device (60) feeds the elongate object through.

12. The cutting system of any of the preceding claims, wherein the cutting device (38) is selected from the group consisting of a mechanical blade and a laser.

13. The cutting system as defined in claim 12, further **characterized in that** the mechanical blade is selected from the group consisting of rotating saw blades and non-rotating saw blades.

14. The cutting system of claim 13, further comprising a sensor device (90) for determining an extent of wear of the at least one circular saw blade.

15. The cutting system of claim 14, wherein the sensor device (90) is selected from the group consisting of:

(1) an electrical conduction sensing circuit coupled to the at lease one circular saw blade and

the elongate object, the elongate object being conductive, and said circuit notifying a position controlling device when an electrical circuit is complete when the at least one circular saw blade comes into contact with the electrically conductive elongate object;
(2) a mechanical drag detection device coupled to the at least one circular saw blade by the driving device or the spindle; and
(3) an optical detector device for detecting a gap between the at least one circular saw blade and the elongate object.

16. The cutting system of claim 15, wherein the mechanical drag detection device is selected from the group consisting of:

(1) a rotation detector device which monitors rotation of the at least one circular saw blade, thereby determining when contact is made by moving the spindle up and down while advancing toward the elongate object; and
(2) a torque detector device which monitors a change in an amount of torque required to turn the at least one circular saw blade.

17. The cutting system according to any of claims 2 to 16, wherein the at least one circular saw blade is more specifically **characterized by** a plurality of circular saw blades, of a same diameter, mounted in parallel and coaxially on the at least one spindle.

18. The cutting system according to any of claims 13 to 17, further comprising a position determining device (80) for determining a position of the elongate object relative to the at least one circular saw blade so that the vertically movable member and the horizontally movable member can be positioned correctly for making an incision.

19. The cutting system according to any of the preceding claims, further comprising a second horizontally movable member (24) having a spindle end and a horizontal coupling face, the second horizontally movable member being slidably coupled at the horizontal coupling face to the first vertically movable member at the first horizontal coupling face.

20. The cutting system of claim 19, further comprising a spindle rotatably coupled to the spindle end of the second horizontally movable member, and having a saw blade mounted coaxially on said spindle.

21. The cutting system as defined in claim 1, wherein the cutting device is further **characterized by**:

a base member (10);
a lever arm coupled to the base member at a pivoting end and capable of horizontal and vertical movement of an opposite spindle end (26);
at least one rotatable spindle (32) disposed through the spindle end;
at least one circular saw blade (38) disposed coaxially on the spindle;
a drive device coupled to the at least one spindle for rotating the at least one circular saw blade; and

wherein the securing device (50) is coupled to the base member (10) and disposed to engage the elongate object while the at least one circular saw blade makes an incision therethrough.

22. A method for forming at least one precision cut in an elongate object (8) such as a catheter or a guidewire using an apparatus including a securing device (50) including a collet clamp, a feeding device (54) including a pinch roller assembly for feeding the elongate object to the clamping device, and a cutting device (38), wherein the cutting device makes at least one precision cut in the elongate object which is generally at an angle or transverse relative to a lengthwise axis thereof, said method **characterized by** the steps of:

(1) feeding the elongate object to the securing device;
(2) manipulating the elongate object into a position that is suitable for making the at least one precision cut therein;
(3) engaging the securing device so as to securely hold the elongate object in the position that is suitable for cutting; and
(4) making the at least one precision cut in the elongate object.

23. The method of claim 22, wherein the apparatus further includes a horizontally movable member (24), a vertically movable member (14) coupled to the horizontally movable member, a spindle (32) coupled to the vertically movable member, and a circular saw blade (38) rotatably disposed on the spindle, the step of making the at least one precision cut in the elongate object being further **characterized by** the additional steps of:

(5) advancing the horizontally movable member a desired cutting depth toward but beneath the elongate object;
(6) upwardly advancing the vertically movable member until the circular saw blade cuts the elongate object; and
(7) lowering the vertically movable member.

24. The method of claim 22, wherein the apparatus further includes a vertically movable member (14), a

horizontally movable member (24) coupled to the vertically movable member, a spindle (32) coupled to the horizontally movable member, and a circular saw blade (38) rotatably disposed on the spindle, the step of making the at least one precision cut in the elongate object being further **characterized by** the additional steps of:

(5) advancing the vertically movable member a desire cutting depth toward but beneath the elongate object;
(6) horizontally advancing the horizontally movable member until the circular saw blade cuts the elongate object; and
(7) horizontally retracting the horizontally movable member.

25. The method of claim 22, wherein the method is **characterized by** the additional steps of

(5) disengaging the securing device from around the elongate object;
(6) advancing the elongate object through the securing device; and
(7) repeating steps 2) through 4) of claim 22 until all desired cuts in the elongate object are completed.

26. The method as defined in claims 22 to 25, wherein the method comprises the additional step of rotating the clamping device to thereby rotate the elongate object clamped therein and expose a different portion of the elongated object for making a cut thereon.

27. The method as defined in claims 22 to 25, wherein the method is **characterized by** the additional step of rotating the securing device and the feeding device to thereby rotate the elongate object clamped therein to expose a different portion of the elongate object for making a cut thereon.

28. The method as defined in claim 22, wherein the method is **characterized by** the additional steps of:

(5) disengaging the securing device;
(6) rotating the feeding device to thereby rotate the elongate object clamped therein to expose a different portion of the elongate object for making a cut thereon; and
(7) engaging the securing device.

Patentansprüche

1. System (6) zum Erzeugen wenigstens eines Präzisionsschnittes in einem länglichen Objekt (8), wie z.B. einem Katheter oder einem Führungsdraht, wobei der Präzisionsschnitt im Allgemeinen in einem Winkel oder quer in Bezug auf eine Längsachse des länglichen Objektes liegt, wobei das System umfasst:

eine Befestigungsvorrichtung (50), die ein Spannfutter (52) aufweist, das dafür konfiguriert ist, das längliche Objekt in einer für das Schneiden des länglichen Objektes in einem Winkel oder quer in Bezug auf die Längsachse geeigneten Position wiederholt freizugeben und zu halten;

eine Manipulationsvorrichtung (54) mit einer Zuführungsvorrichtung, die dafür konfiguriert ist, das längliche Objekt so zu bewegen, dass es in der für den Schneidevorgang geeigneten Position angeordnet werden kann, wenn es von der Befestigungsvorrichtung freigegeben wird; und

eine Schneidevorrichtung (38), die dafür konfiguriert ist, wenigstens einen Präzisionsschnitt in dem länglichen Objekt bis auf jede gewünschte Tiefe auszuführen; und

dadurch gekennzeichnet, dass die Zuführungsvorrichtung eine Andruckrollenanordnung (60) aufweist.

2. Schneidesystem nach Anspruch 1, wobei die Schneidevorrichtung ferner **gekennzeichnet ist, durch**:

ein Basiselement (10);

ein vertikal bewegliches Element (14), das verschiebbar mit dem Basiselement verbunden ist;

ein horizontal bewegliches Element (24) mit einem Spindelende (26) und das verschiebbar mit dem vertikal beweglichen Element verbunden ist;

wenigstens eine drehbare Spindel (32), die **durch** das Spindelende hindurch angeordnet ist;

wenigstens ein rundes Sägeblatt (38), das koaxial auf der Spindel angeordnet ist;

eine Antriebsvorrichtung, die mit der wenigstens einen Spindel verbunden ist, um das wenigstens eine Sägeblatt zu drehen; und

wobei die Befestigungsvorrichtung (50) mit dem Basiselement (10) verbunden ist und angeord-

net ist, mit dem länglichen Objekt in Eingriff zu stehen, während das wenigstens eine Sägeblatt (38) einen Einschnitt **dadurch** hindurch ausführt.

3. Schneidesystem nach Anspruch 1, wobei die Schneidevorrichtung ferner **gekennzeichnet ist, durch**:

ein Basiselement (10);

ein horizontal bewegliches Element (24), das verschiebbar mit dem Basiselement verbunden ist;

ein vertikal bewegliches Element (14) mit einem Spindelende (26) und das verschiebbar mit dem horizontal beweglichen Element verbunden ist;

wenigstens eine drehbare Spindel (32), die **durch** das Spindelende hindurch angeordnet ist;

wenigstens ein rundes Sägeblatt (38), das koaxial auf der Spindel angeordnet ist;

eine Antriebsvorrichtung, die mit der wenigstens einen Spindel verbunden ist, um das wenigstens eine Sägeblatt zu drehen; und

wobei die Befestigungsvorrichtung (50) mit dem Basiselement (10) verbunden ist und angeordnet ist, mit dem länglichen Objekt in Eingriff zu stehen, während das wenigstens eine Sägeblatt (38) einen Einschnitt **dadurch** hindurch ausführt.

4. Schneidesystem nach einem der Ansprüche 1 bis 3, wobei die Schneidevorrichtung (38) ferner **gekennzeichnet ist durch** eine Einrichtung zum Bewegen der Schneidevorrichtung in Bezug auf das längliche Objekt, das **durch** die Befestigungsvorrichtung (50) so festgehalten wird, dass der Präzisionsschnitt in einem Winkel oder quer in Bezug auf die Längsachse des länglichen Objektes ausgeführt werden kann.

5. Schneidesystem nach einem der vorstehenden Ansprüche, wobei die Manipulationsvorrichtung (54) dafür angepasst ist, das Drücken, Ziehen und Wenden des länglichen Objektes in Bezug auf die Schneidevorrichtung (38) und die Befestigungsvorrichtung (50) zu ermöglichen.

6. Schneidesystem nach einem der vorstehenden Ansprüche, wobei die Befestigungsvorrichtung (50) ferner durch eine Vorrichtung zum Drehen des Spannfutters (52) **gekennzeichnet** ist, während das Futter das längliche Objekt unbeweglich hält, und während die Schneidevorrichtung (38) das längliche Objekt schneidet.

7. Schneidesystem nach einem der vorstehenden Ansprüche, wobei die Befestigungsvorrichtung (50), die Manipulationsvorrichtung (54) und die Schneidevorrichtung (38) beweglich und in einer Position in Bezug zueinander befestigbar sind, so dass das längliche Objekt zum Schneiden in einem gewünschten Winkel durch die Befestigungsvorrichtung und die Manipulationsvorrichtung in Bezug auf die Schneidevorrichtung positioniert werden kann.

8. Schneidesystem nach einem der vorstehenden Ansprüche, wobei die Andruckrollenanordnung ferner **gekennzeichnet ist, durch**:

ein erstes Rad (66), um das längliche Objekt zu unterstützen und zu zwingen, sich zu der Befestigungsvorrichtung (50) hin zu bewegen, wenn die Befestigungsvorrichtung gelöst ist;

ein zweites Rad (60) zum Aufbringen einer Kraft auf das längliche Objekt, um es **dadurch** gegen das erste Rad zu halten, um **dadurch** Reibung zu erzeugen, um das längliche Objekt zu der Befestigungsvorrichtung (50) hin zu schieben; und

einen Hebelarm (62), der mit dem Basis an dem Schwenkpunktende verbunden ist, und mit dem zweiten Rad (60) an einem beweglichen Ende verbunden ist, wobei eine Federvorrichtung (64), die zwischen dem Hebelarm und dem Basiselement (10) angeschlossen ist, die Kraft des zweiten Rades bereitstellt.

9. Schneidesystem nach einem der Ansprüche 2 bis 8, wobei das vertikal bewegliche Element (14) eine erste vertikale Verbindungsfläche und eine erste horizontale Verbindungsfläche aufweist, und verschiebbar mit dem Basiselement an der ersten vertikalen Fläche verbunden ist.

10. Schneidesystem nach Anspruch 9, wobei das horizontal bewegliche Element (24) eine zweite horizontale Verbindungsfläche aufweist, wobei das horizontal bewegliche Element verschiebbar an der zweiten horizontalen Verbindungsfläche mit dem vertikal beweglichen Element an der ersten horizontalen Verbindungsfläche verbunden ist.

11. Schneidesystem nach einem der vorstehenden Ansprüche, wobei das Spannfutter (52) ein Spannloch aufweist, durch welches die Zuführungsvorrichtung (60) das längliche Objekt hindurchführt.

12. Schneidesystem nach einem der vorstehenden An-

sprüche, wobei die Schneidevorrichtung (38) aus der aus einer mechanischen Klinge und einem Laser bestehenden Gruppe ausgewählt ist.

13. Schneidesystem nach Anspruch 12, ferner **dadurch gekennzeichnet, dass** die mechanische Klinge aus der aus einer rotierenden Sägeblättern und nicht rotierenden Sägeblättern bestehenden Gruppe ausgewählt ist.

14. Schneidesystem nach Anspruch 13, welches ferner eine Sensorvorrichtung (20) aufweist, um ein Ausmaß eines Verschleißes wenigstens eines runden Sägeblattes zu ermitteln.

15. Schneidesystem nach Anspruch 14, wobei die Sensorvorrichtung (19) aus der Gruppe ausgewählt ist, die besteht aus:

(1) einer elektrische Leitung messenden Schaltung, die mit dem wenigstens einem runden Sägeblatt und dem länglichen Objekt verbunden ist, wobei das längliche Objekt leitend ist, und die Schaltung einer Positionssteuerungsvorrichtung meldet, wenn ein elektrischer Schaltkreis vollständig ist, wenn das wenigstens eine runde Sägeblatt mit dem elektrisch leitenden länglichen Objekt in Kontakt kommt;

(2) einer mechanischen Belastungsdetektionsvorrichtung, die mit dem wenigstens einen runden Sägeblatt über die Antriebsvorrichtung oder die Spindel verbunden ist; und

(3) einer optischen Detektorvorrichtung zum Detektieren eines Spaltes zwischen dem wenigstens einen runden Sägeblatt und dem länglichen Objekt.

16. Schneidesystem nach Anspruch 15, wobei die mechanische Belastungsdetektionsvorrichtung aus der Gruppe ausgewählt ist, die besteht aus:

(1) einer Rotationsdetektorvorrichtung, welche die Rotation des wenigstens einen runden Sägeblattes überwacht, und **dadurch** ermittelt, wann der Kontakt durch Aufwärts- und Abwärtsbewegen der Spindel während des Vorwärtsbewegung zu dem länglichen Objekt hin erfolgt; und

(2) einer Drehmomentdetektorvorrichtung, welche eine Änderung in einem Betrag des erforderlichen Drehmomentes überwacht, das zum Drehen des wenigstens einen runden Sägeblattes erforderlich ist.

17. Schneidesystem nach einem der Ansprüche 2 bis 16, wobei das wenigstens eine runde Sägeblatt insbesondere durch mehrere runde Sägeblätter mit demselben Durchmesser **gekennzeichnet** ist, die parallel und koaxial auf der wenigstens einen Spindel montiert sind.

18. Schneidesystem nach einem der Ansprüche 13 bis 17, welches ferner eine Positionsermittlungsvorrichtung (80) zum Ermitteln einer Position des länglichen Objektes in Bezug auf das wenigstens eine runde Sägeblatt aufweist, so dass das vertikal bewegliche Element und das horizontal bewegliche Element korrekt für die Ausführung eines Einschnittes positioniert werden können.

19. Schneidesystem nach einem der vorstehenden Ansprüche, welches ferner ein zweites horizontal bewegliches Element (24) mit einem Spindelende und einer horizontalen Verbindungsfläche aufweist, wobei das zweite horizontal bewegliche Element verschiebbar an der horizontalen Verbindungsfläche mit dem ersten vertikal beweglichen Element an der ersten horizontalen Verbindungsfläche verbunden ist.

20. Schneidesystem nach Anspruch 19, welches ferner eine Spindel aufweist, die drehbar mit dem Spindelende des zweiten horizontal beweglichen Elementes verbunden ist, und ein Sägeblatt aufweist, das koaxial auf der Spindel montiert ist.

21. Schneidesystem nach Anspruch 1, wobei die Schneidevorrichtung ferner **gekennzeichnet ist, durch**:

ein Basiselement (10);

einen Hebelarm, der mit dem Basiselement an einem Schwenkpunktende verbunden ist und zu einer horizontalen und vertikalen Bewegung des entgegengesetzten Spindelendes (26) fähig ist;

wenigstens eine drehbare Spindel (32), die **durch** das Spindelende hindurch angeordnet ist;

wenigstens ein rundes Sägeblatt (38), das koaxial auf der Spindel angeordnet ist;

eine Antriebsvorrichtung, die mit der wenigstens einen Spindel verbunden ist, um das wenigstens eine Sägeblatt zu drehen; und

wobei die Befestigungsvorrichtung (50) mit dem Basiselement (10) verbunden ist und angeordnet ist, mit dem länglichen Objekt in Eingriff zu stehen, während das wenigstens eine Sägeblatt (38)

einen Einschnitt **dadurch** hindurch ausführt.

22. Verfahren zum Erzeugen wenigstens eines Präzisionsschnittes in einem länglichen Objekt (8), wie z. B. einem Katheter oder einem Führungsdraht unter Verwendung einer Vorrichtung (50), die eine ein Spannfutter enthaltende Befestigungsvorrichtung (50), eine eine Andruckrollenanordnung enthaltende Zuführungsvorrichtung (54) zum Zuführen des länglichen Objektes zu der Spannvorrichtung, und eine Schneidevorrichtung (38) enthält, wobei die Schneidevorrichtung wenigstens einen Präzisionsschnitt in dem länglichen Objekt ausführt, welcher im Allgemeinen in einem Winkel oder quer in Bezug auf dessen Längsachse liegt, wobei das Verfahren **gekennzeichnet ist durch** die Schritte:

(1) Zuführen des länglichen Objektes zu der Befestigungsvorrichtung;

(2) Manipulieren des länglichen Objektes in eine Position, die für die Ausführung des wenigstens einen Präzisionsschnittes darin geeignet ist;

(3) Aktivieren der Befestigungsvorrichtung so, dass sie das längliche Objekt sicher in der Position festhält, die zum Schneiden geeignet ist; und

(4) Ausführen des wenigstens einen Präzisionsschnittes in dem länglichen Objekt.

23. Verfahren nach Anspruch 22, wobei die Vorrichtung ferner ein horizontal bewegliches Element (24), ein mit dem horizontal beweglichen Element verbundenes vertikal bewegliches Element (14), eine mit dem vertikal beweglichen Element verbundene Spindel (32), und ein drehbar auf der Spindel angeordnetes rundes Sägeblatt (38) aufweist, wobei der Schritt der Ausführung des wenigstens einen Präzisionsschnittes in dem länglichen Objekt ferner **gekennzeichnet ist durch** die zusätzlichen Schritte:

(5) Vorschieben des horizontal beweglichen Elementes auf eine gewünschte Schnitttiefe auf das länglichen Objektes hin aber unter diesem;

(6) Aufwärtsverschieben des vertikal beweglichen Elementes, bis das runde Sägeblatt das längliche Objekt schneidet; und

(7) Absenken des vertikal beweglichen Elementes.

24. Verfahren nach Anspruch 22, wobei die Vorrichtung ferner ein vertikal bewegliches Element (14), ein mit dem vertika1 beweglichen Element verbundenes horizontal bewegliches Element (24), eine mit dem horizontal beweglichen Element verbundene Spindel (32), und ein drehbar auf der Spindel angeordnetes rundes Sägeblatt (38) aufweist, wobei der Schritt der Ausführung des wenigstens einen Präzisionsschnittes in dem länglichen Objekt ferner **gekennzeichnet ist durch** die zusätzlichen Schritte:

(5) Vorschieben des vertikal beweglichen Elementes auf eine gewünschte Schnitttiefe auf das länglichen Objektes hin aber unter diesem;

(6) horizontales Verschieben des horizontal beweglichen Elementes, bis das runde Sägeblatt das längliche Objekt schneidet; und

(7) horizontales Zurückziehen des horizontal beweglichen Elementes.

25. Verfahren nach Anspruch 22, wobei das Verfahren ferner **gekennzeichnet ist durch** die zusätzlichen Schritte:

(5) Lösen der Befestigungsvorrichtung um das längliche Objekt herum;

(6) Vorschieben des länglichen Objektes **durch** die Befestigungsvorrichtung; und

(7) Wiederholen der Schritte 2) bis 4) von Anspruch 22, bis die gewünschten Schnitte in dem länglichen Objekt abgeschlossen sind.

26. Verfahren nach den Ansprüchen 22 bis 25, wobei das Verfahren den zusätzlichen Schritt der Drehung der Spannvorrichtung aufweist, um **dadurch** das darin festgeklemmte Objekt zu drehen und einen anderen Abschnitt des länglichen Objektes für die Ausführung eines Schnittes daran zur Verfügung zu stellen.

27. Verfahren nach den Ansprüchen 22 bis 25, wobei das Verfahren durch den zusätzlichen Schritt einer Drehung der Befestigungsvorrichtung **gekennzeichnet** ist, um **dadurch** das darin festgeklemmte Objekt zu drehen und einen anderen Abschnitt des länglichen Objektes für die Ausführung eines Schnittes daran zur Verfügung zu stellen.

28. Verfahren nach Anspruch 22, wobei das Verfahren ferner **gekennzeichnet ist durch** die zusätzlichen Schritte:

(5) Lösen der Befestigungsvorrichtung;

(6) Drehen der Zuführungsvorrichtung, um **dadurch** das darin eingeklemmte längliche Ob-

jekt zu drehen, um einen anderen Abschnitt des länglichen Objektes für die Ausführung eines Schnittes daran zur Verfügung zu stellen; und

(7) Feststellen der Befestigungsvorrichtung.

Revendications

1. Système (6) pour former au moins une incision de précision dans un objet de forme allongée (8) tel qu'un cathéter ou un fil guide, dans lequel l'incision de précision est, d'un point de vue général, en angle ou transversale par rapport à un axe longitudinal de l'objet de forme allongée, ledit système comprenant :

   un dispositif de retenue (50) comprenant une pince de serrage (52), configuré pour répétitivement libérer puis immobiliser l'objet de forme allongée dans une position adaptée au découpage de l'objet allongé selon un angle ou transversalement par rapport à l'axe longitudinal ;
   un dispositif de manipulation (54), comprenant un dispositif d'alimentation, configuré pour déplacer l'objet de forme allongée de façon qu'il puisse être disposé dans la position adaptée à l'incision lorsqu'il est libéré par le dispositif de retenue ; et
   un dispositif de coupe (38) configuré pour former ladite au moins une incision de précision dans l'objet de forme allongée selon toute profondeur désirée ; et

   caractérisé en ce que le dispositif de retenue comprend un ensemble à rouleau pinceur (60).

2. Système de coupe selon la revendication 1, dans lequel le dispositif de coupe est ***caractérisé*** en plus ***par*** :

   un élément de socle (10) ;
   un élément mobile verticalement (14) couplé de manière coulissante à l'élément de socle ;
   un élément mobile horizontalement (24) ayant une extrémité (26) à broche et étant couplé de manière coulissante à l'élément mobile verticalement ;
   au moins une broche rotative (32) disposée à travers l'extrémité à broche ;
   au moins une lame (38) de scie circulaire disposée sur la broche de manière coaxiale ;
   un dispositif d'entraînement couplé à ladite au moins une broche destinée à entraîner en rotation ladite au moins une scie circulaire ; et

   dans lequel le dispositif de retenue (50) est couplé à l'élément de socle (10) et est disposé de manière à engager l'objet de forme allongée pendant que ladite au moins une lame (38) de scie circulaire pratique une incision à travers celui-ci.

3. Système de coupe selon la revendication 1, dans lequel le dispositif de coupe est ***caractérisé*** en plus ***par*** ;
   un élément de socle (10) ;
   un élément mobile horizontalement (24) couplé de manière coulissante à l'élément de socle ;
   un élément mobile verticalement (14) ayant une extrémité (26) à broche et étant couplé de manière coulissante à l'élément mobile horizontalement ;
   au moins une broche rotative (32) disposée à travers l'extrémité à broche ;
   au moins une lame (38) de scie circulaire disposée sur la broche de manière coaxiale ;
   un dispositif d'entraînement couplé à ladite au moins une broche destiné à entraîner en rotation ladite au moins une scie circulaire ; et
   dans lequel le dispositif de retenue (50) est couplé à l'élément de socle (10) et est disposé de manière à engager l'objet de forme allongée pendant que ladite au moins une lame (38) de scie circulaire pratique une incision à travers celui-ci.

4. Système de coupe selon l'une quelconque des revendications 1 à 3, dans lequel le dispositif de coupe (38) est ***caractérisé en*** plus ***par*** un moyen pour déplacer le dispositif de coupe relativement à l'objet de forme allongée qui est immobilisé par le dispositif de retenue (50) de telle sorte que l'incision de précision puisse être réalisée angulairement ou transversalement par rapport à l'axe longitudinal de l'objet de forme allongée.

5. Système de coupe selon l'une quelconque des revendications précédentes, dans lequel le dispositif de manipulation (54) est apte à permettre de pousser, de tirer et de faire tourner l'objet de forme allongée par rapport au dispositif de coupe (38) et au dispositif de retenue (50).

6. Système de coupe selon l'une quelconque des revendications précédentes, dans lequel le dispositif de retenue (50) est ***caractérisé*** en plus ***par*** un dispositif pour entraîner en rotation la pince de serrage (52) pendant que la pince immobilise l'objet de forme allongée, et pendant que le dispositif de coupe (38) incise l'objet de forme allongée.

7. Système de coupe selon l'une quelconque des revendications précédentes, dans lequel le dispositif de retenue (50), le dispositif de manipulation (54) et le dispositif de coupe (38) sont mobiles et assujettissables dans une position donnée les uns par rapport aux autres, de telle sorte que l'objet de for-

me allongée puisse être positionné selon un angle désiré pour son découpage, par le dispositif de retenue et par le dispositif de manipulation par rapport au dispositif de coupe.

8. Système de coupe selon l'une quelconque des revendications précédentes, dans lequel l'ensemble à rouleau pinceur est ***caractérisé*** en plus ***par*** :

   une première roulette (66) destinée à supporter l'objet de forme allongée et à le forcer à se déplacer jusqu'à un dispositif de retenue (50) lorsque le dispositif de retenue est débrayé ;
   une deuxième roulette (60) destinée à appliquer une force sur l'objet de forme allongée afin de l'immobiliser ainsi contre la première roulette, assurant ainsi une friction pour pousser l'objet de forme allongée vers le dispositif de retenue (50) ; et
   un bras de levier (62) couplé au socle au niveau d'une extrémité pivotante, et couplé à la deuxième roulette (60) au niveau d'une extrémité mobile, dans lequel un dispositif à ressort (64) couplé entre le bras de levier et l'élément de socle (10) fournit la force pour la deuxième roulette.

9. Système de coupe selon l'une quelconque des revendications 2 à 8, dans lequel l'élément mobile verticalement (14) possède une première face de couplage verticale et une première face de couplage horizontale, et est couplé de manière coulissante à l'élément de socle au niveau de la première face verticale.

10. Système de coupe selon la revendication 9, dans lequel l'élément mobile horizontalement (24) possède une deuxième face de couplage horizontale, l'élément mobile horizontalement étant couplé de manière coulissante au niveau de la deuxième face de couplage horizontale, à l'élément mobile verticalement au niveau de la première face de couplage horizontale.

11. Système de coupe selon l'une quelconque des revendications précédentes, dans lequel la pince de serrage (52) comprend un trou de serrage à travers lequel le dispositif d'alimentation (60) alimente l'objet de forme allongée.

12. Système de coupe selon l'une quelconque des revendications précédentes, dans lequel le dispositif de coupe (38) est choisi dans le groupe se composant d'une lame mécanique et d'un laser.

13. Système de coupe selon la revendication 12, ***caractérisé*** en plus ***en ce que*** la lame mécanique est choisie dans le groupe se composant des lames de scie rotative et des lames de scie non rotative.

14. Système de coupe selon la revendication 13, comprenant de plus un dispositif de détection (90) destiné à déterminer l'étendue de l'usure de ladite au moins une lame de scie circulaire.

15. Système de coupe selon la revendication 14, dans lequel le dispositif de détection (90) est choisi dans le groupe se composant de :

   (1) un circuit détecteur de conduction électrique couplé à ladite au moins une lame de scie circulaire et à l'objet de forme allongée, l'objet de forme allongée étant conducteur, et ledit circuit signalant à un dispositif de contrôle de position qu'un circuit électrique est complet lorsque ladite au moins une lame de scie circulaire vient en contact avec l'objet de forme allongée conducteur électrique ;
   (2) un dispositif de détection de traînée (résistance) mécanique couplé à ladite au moins une lame de scie circulaire par le dispositif d'entraînement ou la broche ; et
   (3) un dispositif de détection optique destiné à détecter un espace libre entre ladite au moins une lame de scie circulaire et l'objet de forme allongée.

16. Système de coupe selon la revendication 15, dans lequel le dispositif de détection de traînée mécanique est choisi dans le groupe se composant de :

   (1) un dispositif de détection de rotation qui contrôle la rotation de ladite au moins une lame de scie circulaire, déterminant ainsi lorsqu'un contact est réalisé par le déplacement de haut en bas de la broche tout en avançant en direction de l'objet de forme allongée ; et
   (2) un dispositif de détection de couple qui contrôle un changement dans une valeur de couple nécessaire pour faire tourner ladite au moins une lame de scie circulaire.

17. Système de coupe selon l'une quelconque des revendications 2 à 16, dans lequel ladite au moins une lame de scie circulaire est plus spécifiquement ***caractérisée par*** une pluralité de lames de scie circulaire de même diamètre, montées en parallèle et coaxialement sur ladite au moins une broche.

18. Système de coupe selon l'une quelconque des revendications 13 à 17, comprenant de plus un dispositif (80) de détermination de position destiné à déterminer une position de l'objet de forme allongée par rapport à ladite au moins une lame de scie circulaire de telle sorte que l'élément mobile verticalement et l'élément mobile horizontalement puis-

sent être positionnés correctement pour pratiquer une incision.

19. Système de coupe selon l'une quelconque des revendications précédentes, comprenant de plus un deuxième élément mobile horizontalement (24) ayant une extrémité à broche et une face de couplage horizontale, le deuxième élément mobile horizontalement étant couplé de manière coulissante au niveau de la face de couplage horizontale au premier élément mobile verticalement au niveau de la première face de couplage horizontale.

20. Système de coupe selon la revendication 19, comprenant de plus une broche couplée rotativement à l'extrémité de broche du deuxième élément mobile horizontalement, et ayant une lame de scie montée coaxialement sur ladite broche.

21. Système de coupe selon la revendication 1, dans lequel le dispositif de coupe est **caractérisé** en plus par :

un élément de socle (10) ;
un élément de levier couplé à l'élément de base au niveau d'une extrémité pivotante et apte au mouvement horizontal et vertical d'une extrémité (26) à broche opposée
au moins une broche rotative (32) disposée à travers l'extrémité à broche ;
au moins une lame (38) de scie circulaire disposée sur la broche de manière coaxiale ;
un dispositif d'entraînement couplé à ladite au moins une broche destiné à entraîner en rotation ladite au moins une scie circulaire ; et

dans lequel le dispositif de retenue (50) est couplé à l'élément de socle (10) et est disposé de manière à engager l'objet de forme allongée pendant que ladite au moins une lame de scie circulaire pratique une incision à travers celui-ci.

22. Procédé pour former au moins une incision de précision dans un objet de forme allongée (8) tel qu'un cathéter ou un fil guide, en utilisant un système comprenant un dispositif de retenue (50) comprenant une pince de serrage (52), un dispositif de manipulation (54), comprenant un ensemble à rouleau pinceur pour alimenter l'objet de forme allongée dans le dispositif de serrage, et un dispositif de coupe (38), dans lequel le dispositif de coupe pratique au moins une incision de précision dans l'objet de forme allongée qui est généralement en angle ou transversal par rapport à un axe longitudinal de celui-ci, ledit procédé étant **caractérisé par** les étapes consistant à :

(1) alimenter l'objet de forme allongée au dispositif de retenue ;
(2) manipuler l'objet de forme allongée dans une position qui est adaptée pour y pratiquer au moins une incision de précision ;
(3) engager le dispositif de retenue afin d'immobiliser l'objet de forme allongée dans la position qui est adaptée pour l'incision ; et
(4) pratiquer ladite au moins une incision de précision dans l'objet de forme longitudinale.

23. Procédé selon la revendication 22, dans lequel le système comprend de plus un élément mobile horizontalement (24), un élément mobile verticalement (14) couplé à l'élément mobile horizontalement, une broche (32) couplée à l'élément mobile verticalement, et une lame (38) de scie circulaire montée rotativement sur la broche, l'étape de réalisation d'au moins une incision de précision dans l'objet de forme allongée étant ***caractérisée*** en plus ***par*** les étapes supplémentaires consistant à :

(5) faire avancer l'élément mobile horizontalement d'une profondeur de coupe désirée en direction de l'objet de forme allongée, mais au-dessous de celui-ci ;
(6) faire avancer vers le haut l'élément mobile verticalement jusqu'à ce que la lame de scie incise l'objet de forme allongée ; et
(7) abaisser l'élément mobile verticalement.

24. Procédé selon la revendication 22, dans lequel le système comprend en plus un élément mobile verticalement (14), un élément mobile horizontalement (24) couplé à l'élément mobile verticalement, une broche (32) couplée à l'élément mobile horizontalement, et une lame (38) de scie circulaire montée rotativement sur la broche, l'étape de réalisation d'au moins une incision de précision dans l'objet de forme allongée étant ***caractérisée*** en plus ***par*** les étapes supplémentaires consistant à :

(5) faire avancer l'élément mobile verticalement d'une profondeur de coupe désirée en direction de l'objet de forme allongée, mais au-dessous de celui-ci ;
(6) faire avancer vers le haut l'élément mobile horizontalement jusqu'à ce que la lame de scie incise l'objet de forme allongée ; et
(7) rétracter horizontalement l'élément mobile horizontalement.

25. Procédé selon la revendication 22, dans lequel le procédé est ***caractérisé par*** les étapes supplémentaires consistant à :

(5) dégager le dispositif de retenue de son emprise autour de l'objet de forme allongée ;
(6) faire avancer l'objet de forme allongée à tra-

vers le dispositif de retenue ; et
(7) répéter les étapes (2) à (4) de la revendication 22 jusqu'à ce que le nombre désiré d'incisions dans l'objet de forme allongée ait été obtenu.

26. Procédé selon les revendications 22 à 25, dans lequel le procédé comprend l'étape supplémentaire de rotation du dispositif de retenue afin de faire tourner l'objet de forme allongée qui y est immobilisé et d'exposer une portion différente de l'objet de forme allongée pour y pratiquer une incision.

27. Procédé selon les revendications 22 à 25, dans lequel le procédé est ***caractérisé par*** l'étape supplémentaire de rotation du dispositif de retenue et du dispositif d'alimentation afin de faire tourner l'objet de forme allongée qui y est immobilisé pour exposer une portion différente de l'objet de forme allongée pour y pratiquer une incision.

28. Procédé selon la revendication 22, dans lequel le procédé est **caractérisé par** les étapes supplémentaires consistant à :

(5) dégager le dispositif de retenue ;
(6) faire tourner le dispositif d'alimentation pour ainsi faire tourner l'objet de forme allongée qui y est immobilisé afin d'exposer une portion différente de l'objet de forme allongée pour y pratiquer une incision ; et
(7) engager le dispositif de retenue.

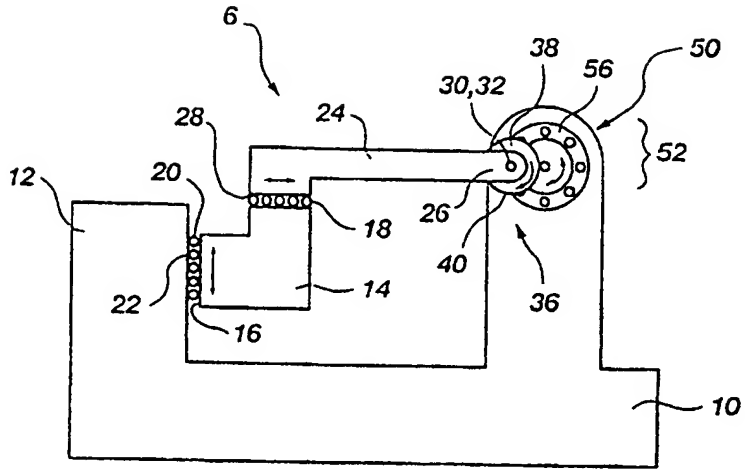

Fig. 1A

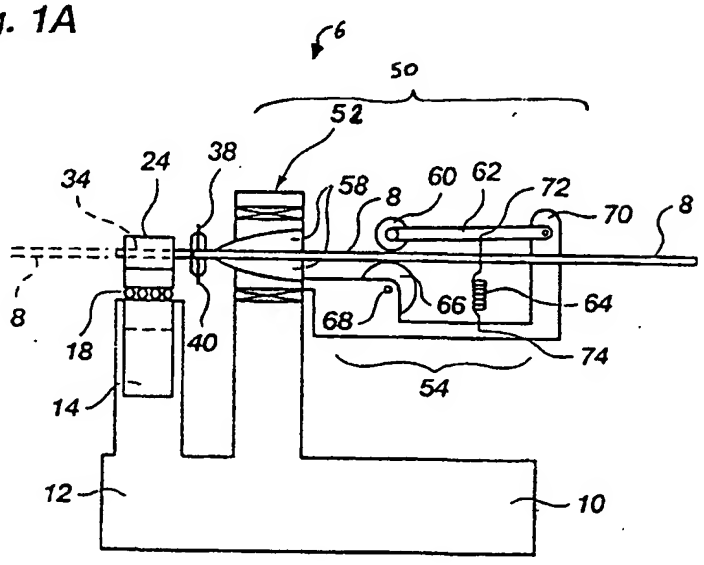

Fig. 1B

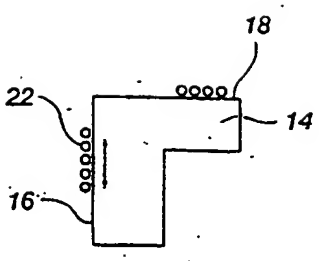

Fig. 2

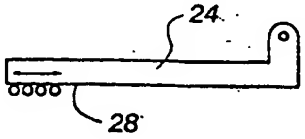

Fig. 3

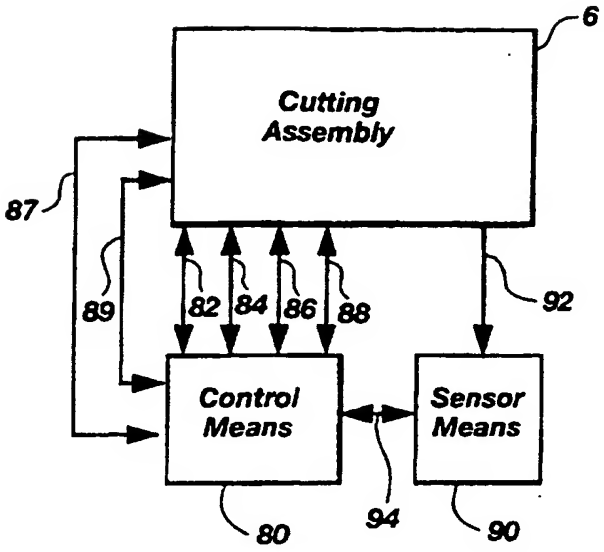

Fig. 4

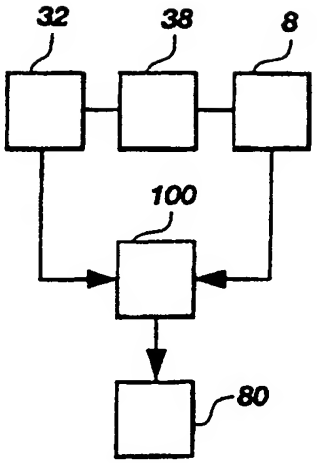

Fig. 5

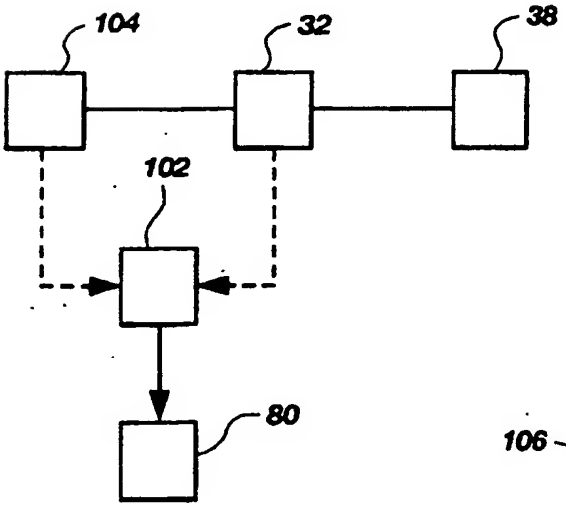

Fig. 6

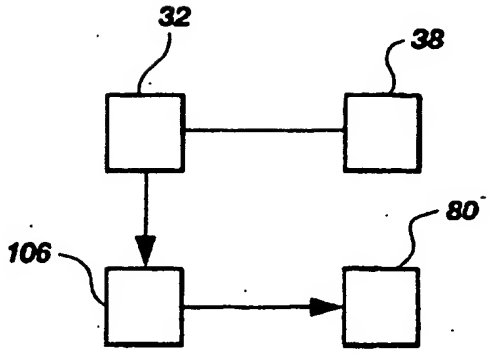

Fig. 7

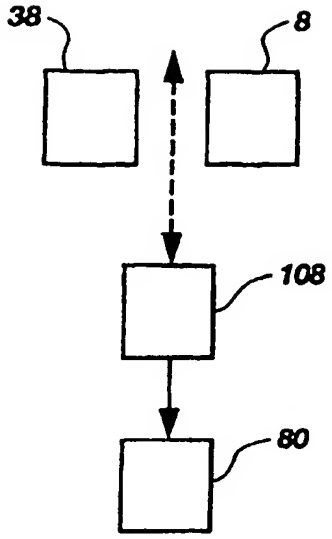

Fig. 8

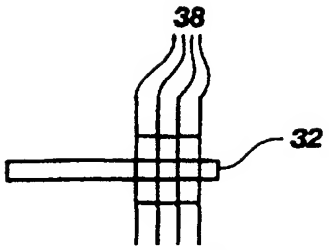

Fig. 9

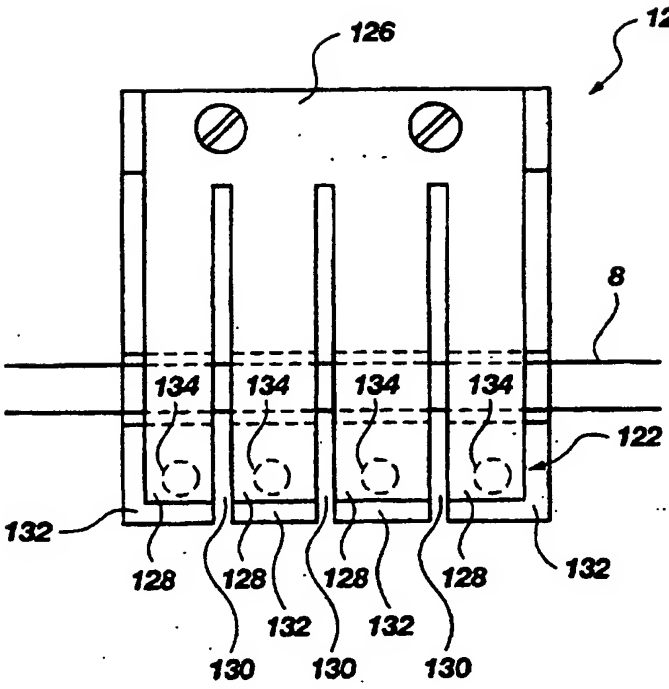

Fig. 10A

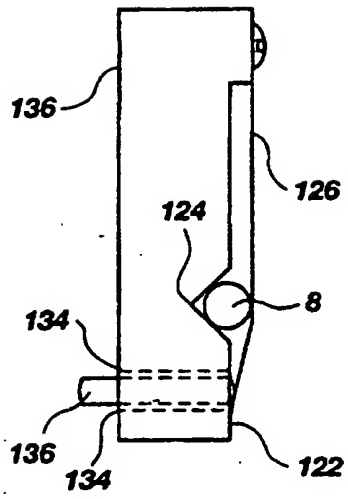

Fig. 10B

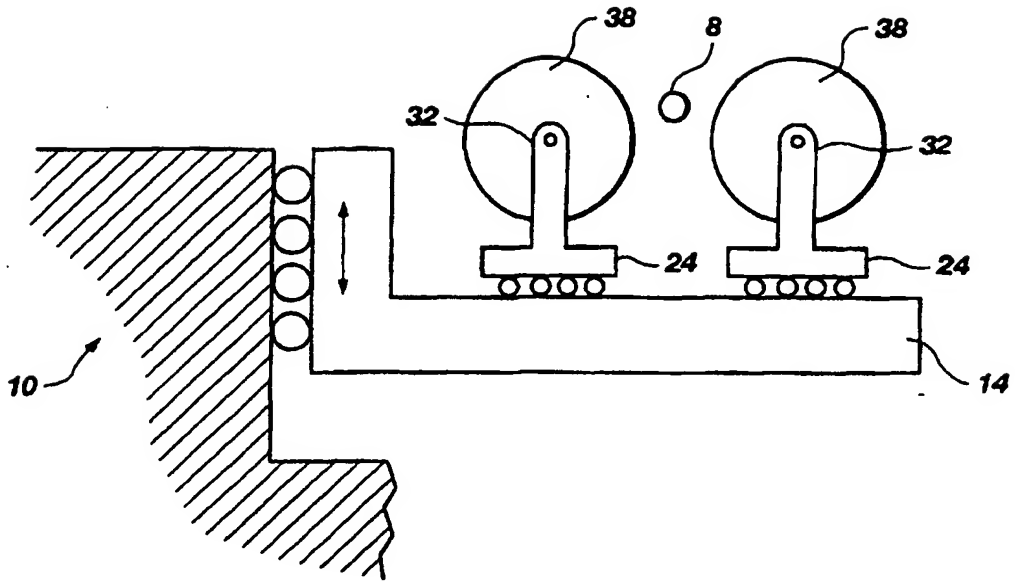

Fig. 11